

WHAT IS CLAIMED IS:

1. A cleaning device for cleaning toner from an image carrier that carries a toner image made of toner, comprising:
  - a blade member having an end, wherein the end touches a
  - 5 surface of the image carrier and scraps off toner from the surface;
  - a vibratable member to which the blade member is fixed; and
  - a vibrating unit that vibrates the vibratable member so that the end of the blade member does not curl.
- 10 2. The cleaning device according to claim 1, wherein
  - the blade member has a length, and
  - the blade member is situated such that length of the blade member is parallel to an axis of rotation of the image carrier and the blade member makes an acute angle with a tangent to the surface of
  - 15 the image carrier in a direction of rotation of the image carrier.
3. The cleaning device according to claim 1, wherein the angle is between 0 degree and 50 degrees.
- 20 4. The cleaning device according to claim 1, wherein the vibratable member presses the blade member against the image carrier.
5. The cleaning device according to claim 1, further comprising a force imparting unit that imparts pressing force to the vibratable
- 25 member to thereby press the end of the blade member against the

image carrier.

6. The cleaning device according to claim 1, wherein the vibrating unit is a piezoelectric element.

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7. The cleaning device according to claim 6, wherein the piezoelectric element is plate-like and fixed to the vibratable member.

8. The cleaning device according to claim 7, wherein the  
10 piezoelectric element expands and contracts to thereby vibrate the vibratable member.

9. The cleaning device according to claim 7, wherein the  
15 piezoelectric element has an electrode, and the electrode is electrically connected to the vibratable member.

10. The cleaning device according to claim 6, wherein the vibratable member has a fixed end and a free end, and the piezoelectric element is fixed to the vibratable member between the fixed end and the free  
20 end.

11. The cleaning device according to claim 6, wherein the piezoelectric element is a laminated type piezoelectric element that displaces the vibratable member in a laminating direction as d-33  
25 direction.

12. The cleaning device according to claim 6, wherein the piezoelectric element is a laminated type piezoelectric element that displaces the vibratable member in a face direction as d-31 direction, wherein the face direction is a direction perpendicular to the laminating direction.

13. The cleaning device according to claim 1, wherein the vibrating unit is fixed to the vibratable member, and the vibratable member is stiffer in a portion where the blade member is fixed than in a portion where the vibrating unit is fixed.

14. The cleaning device according to claim 1, wherein the vibrating unit is fixed to the vibratable member, the vibratable member is stiffer than the blade member, and a distance between the end of the blade member and an end of the blade member is between one to two times a thickness of the blade member.

15. The cleaning device according to claim 1, wherein the vibrating unit is fixed to the vibratable member, the vibratable member is stiffer than the blade member, the vibratable member having an end, wherein the end of the blade member and the end of the vibratable member are at same level or the end of the blade member protrudes towards the image carrier than the end of the vibratable member.

16. The cleaning device according to claim 1, wherein a plurality of the vibrating units are arranged at predetermined interval along a width of the vibratable member.

5 17. The cleaning device according to claim 16, further comprising a drive circuit that drives the vibrating units.

18. A cleaning device for cleaning toner from an image carrier that carries a toner image made of toner, comprising:

10 a blade member having an end, wherein the end is pressed against a surface of the image carrier for a specified amount to thereby scrap off toner from the surface;

a vibratable member to which the blade member is fixed; and

a vibrating unit that vibrates the vibratable member in such a  
15 manner that amplitude of the vibrations is smaller than the specified amount for which the blade member is pressed against the surface of the image carrier.

19. The cleaning device according to claim 18, wherein amplitude of  
20 vibration of the end of the blade member is smaller than an average particle size of the toner.

20. The cleaning device according to claim 18, wherein  
the blade member has a length, and  
25 the blade member is situated such that length of the blade

member is parallel to an axis of rotation of the image carrier and the blade member makes an acute angle with a tangent to the surface of the image carrier in a direction of rotation of the image carrier.

5    21.    The cleaning device according to claim 18, wherein the angle is between 0 degree and 50 degrees.

22.    The cleaning device according to claim 18, wherein the vibratable member presses the blade member against the image carrier.

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23.    The cleaning device according to claim 18, further comprising a force imparting unit that imparts pressing force to the vibratable member to thereby press the end of the blade member against the image carrier.

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24.    The cleaning device according to claim 18, wherein the vibrating unit is a piezoelectric element.

25.    The cleaning device according to claim 24, wherein the  
20    piezoelectric element is plate-like and fixed to the vibratable member.

26.    The cleaning device according to claim 25, wherein the piezoelectric element expands and contracts to thereby vibrate the vibratable member.

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27. The cleaning device according to claim 25, wherein the piezoelectric element has an electrode, and the electrode is electrically connected to the vibratable member.

5 28. The cleaning device according to claim 24, wherein the vibratable member has a fixed end and a free end, and the piezoelectric element is fixed to the vibratable member between the fixed end and the free end.

10 29. The cleaning device according to claim 24, wherein the piezoelectric element is a laminated type piezoelectric element that displaces the vibratable member in a laminating direction as d-33 direction.

15 30. The cleaning device according to claim 24, wherein the piezoelectric element is a laminated type piezoelectric element that displaces the vibratable member in a face direction as d-31 direction, wherein the face direction is a direction perpendicular to the laminating direction.

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31. The cleaning device according to claim 18, wherein the vibrating unit is fixed to the vibratable member, and the vibratable member is stiffer in a portion where the blade member is fixed than in a portion where the vibrating unit is fixed.

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32. The cleaning device according to claim 18, wherein the vibrating unit is fixed to the vibratable member, the vibratable member is stiffer than the blade member, and a distance between the end of the blade member and an end of the blade member is between one to two times a thickness of the blade member.

33. The cleaning device according to claim 18, wherein the vibrating unit is fixed to the vibratable member, the vibratable member is stiffer than the blade member, the vibratable member having an end, wherein the end of the blade member and the end of the vibratable member are at same level or the end of the blade member protrudes towards the image carrier than the end of the vibratable member.

34. The cleaning device according to claim 18, wherein a plurality of the vibrating units are arranged at predetermined interval along a width of the vibratable member.

35. The cleaning device according to claim 34, further comprising a drive circuit that drives the vibrating units.

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36. A cleaning device for cleaning toner from an image carrier that carries a toner image made of toner, comprising:  
a blade member having an end, wherein the end is pressed against a surface of the image carrier for a specified amount to thereby scrap off toner from the surface;

a vibratable member to which the blade member is fixed; and  
a vibrating unit that vibrates the vibratable member in such a  
manner that toner that is not in contact with the end of the blade  
member is vibrated.

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37. The cleaning device according to claim 36, wherein  
the blade member has a length, and

the blade member is situated such that length of the blade  
member is parallel to an axis of rotation of the image carrier and the  
10 blade member makes an acute angle with a tangent to the surface of  
the image carrier in a direction of rotation of the image carrier.

38. The cleaning device according to claim 36, wherein the angle is  
between 0 degree and 50 degrees.

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39. The cleaning device according to claim 36, wherein the  
vibratable member presses the blade member against the image carrier.

40. The cleaning device according to claim 36, further comprising a  
20 force imparting unit that imparts pressing force to the vibratable  
member to thereby press the end of the blade member against the  
image carrier.

41. The cleaning device according to claim 36, wherein the vibrating  
25 unit is a piezoelectric element.



42. The cleaning device according to claim 41, wherein the piezoelectric element is plate-like and fixed to the vibratable member.

43. The cleaning device according to claim 42, wherein the  
5 piezoelectric element expands and contracts to thereby vibrate the vibratable member.

44. The cleaning device according to claim 42, wherein the piezoelectric element has an electrode, and the electrode is electrically  
10 connected to the vibratable member.

45. The cleaning device according to claim 41, wherein the vibratable member has a fixed end and a free end, and the piezoelectric element is fixed to the vibratable member between the fixed end and  
15 the free end.

46. The cleaning device according to claim 41, wherein the piezoelectric element is a laminated type piezoelectric element that displaces the vibratable member in a laminating direction as d-33  
20 direction.

47. The cleaning device according to claim 41, wherein the piezoelectric element is a laminated type piezoelectric element that displaces the vibratable member in a face direction as d-31 direction,  
25 wherein the face direction is a direction perpendicular to the laminating

direction.

48. The cleaning device according to claim 36, wherein the vibrating unit is fixed to the vibratable member, and the vibratable member is  
5 stiffer in a portion where the blade member is fixed than in a portion where the vibrating unit is fixed.

49. The cleaning device according to claim 36, wherein the vibrating unit is fixed to the vibratable member, the vibratable member is stiffer  
10 than the blade member, and a distance between the end of the blade member and an end of the blade member is between one to two times a thickness of the blade member.

50. The cleaning device according to claim 36, wherein the vibrating  
15 unit is fixed to the vibratable member, the vibratable member is stiffer than the blade member, the vibratable member having an end, wherein the end of the blade member and the end of the vibratable member are at same level or the end of the blade member protrudes towards the image carrier than the end of the vibratable member.

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51. The cleaning device according to claim 36, wherein a plurality of the vibrating units are arranged at predetermined interval along a width of the vibratable member.

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52. The cleaning device according to claim 51, further comprising a drive circuit that drives the vibrating units.

53. A process cartridge comprising:

5 an image carrier that carries a toner image made of toner;

and

a cleaning unit having

a blade member having an end, wherein the end touches a surface of the image carrier and scraps off toner from the surface;

10 a vibratable member to which the blade member is fixed;

and

a vibrating unit that vibrates the vibratable member so that the end of the blade member does not curl.

15 54. A process cartridge comprising:

an image carrier that carries a toner image made of toner;

and

a cleaning unit having

a blade member having an end, wherein the end is pressed against a surface of the image carrier for a specified amount to thereby scrap off toner from the surface;

20 a vibratable member to which the blade member is fixed;

and

a vibrating unit that vibrates the vibratable member in such a manner that amplitude of the vibrations is smaller than the

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specified amount for which the blade member is pressed against the surface of the image carrier.

55. A process cartridge comprising:
- 5 an image carrier that carries a toner image made of toner;
- and
- a cleaning unit having
- a blade member having an end, wherein the end is pressed against a surface of the image carrier for a specified amount to
- 10 thereby scrap off toner from the surface;
- a vibratable member to which the blade member is fixed;
- and
- a vibrating unit that vibrates the vibratable member in such a manner that toner that is not in contact with the end of the blade
- 15 member is vibrated.

56. An image forming apparatus comprising:
- an image carrier that carries a toner image made of toner; and
- a cleaning unit having
- 20 a blade member having an end, wherein the end touches a surface of the image carrier and scraps off toner from the surface;
- a vibratable member to which the blade member is fixed;
- and
- a vibrating unit that vibrates the vibratable member so
- 25 that the end of the blade member does not curl.

57. An image forming apparatus comprising:

an image carrier that carries a toner image made of toner; and

a cleaning unit having

a blade member having an end, wherein the end is

5 pressed against a surface of the image carrier for a specified amount to  
thereby scrap off toner from the surface;

a vibratable member to which the blade member is fixed;

and

a vibrating unit that vibrates the vibratable member in

10 such a manner that amplitude of the vibrations is smaller than the  
specified amount for which the blade member is pressed against the  
surface of the image carrier.

58. An image forming apparatus comprising:

15 an image carrier that carries a toner image made of toner; and

a cleaning unit having

a blade member having an end, wherein the end is

pressed against a surface of the image carrier for a specified amount to  
thereby scrap off toner from the surface;

20 a vibratable member to which the blade member is fixed;

and

a vibrating unit that vibrates the vibratable member in

such a manner that toner that is not in contact with the end of the blade  
member is vibrated.

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59. An image forming apparatus comprising a plurality of process cartridges, each process cartridge including

an image carrier that carries a toner image made of toner;

a charging unit that electrically charges the image carrier;

5 a developing unit that develops the toner images on the image carries;

a transfer unit that transfers the developed toner image onto a recording medium; and

a cleaning unit having

10 a blade member having an end, wherein the end touches a surface of the image carrier and scraps off toner from the surface;

a vibratable member to which the blade member is fixed;

and

a vibrating unit that vibrates the vibratable member so

15 that the end of the blade member does not curl.

60. An image forming apparatus comprising a plurality of process cartridges, each process cartridge including

an image carrier that carries a toner image made of toner;

20 a charging unit that electrically charges the image carrier;

a developing unit that develops the toner images on the image carries;

a transfer unit that transfers the developed toner image onto a recording medium; and

25 a cleaning unit having

a blade member having an end, wherein the end is pressed against a surface of the image carrier for a specified amount to thereby scrap off toner from the surface;

a vibratable member to which the blade member is fixed;

5 and

a vibrating unit that vibrates the vibratable member in such a manner that amplitude of the vibrations is smaller than the specified amount for which the blade member is pressed against the surface of the image carrier.

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61. An image forming apparatus comprising a plurality of process cartridges, each process cartridge including

an image carrier that carries a toner image made of toner;

a charging unit that electrically charges the image carrier;

15 a developing unit that develops the toner images on the image carries;

a transfer unit that transfers the developed toner image onto a recording medium; and

a cleaning unit having

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a blade member having an end, wherein the end is pressed against a surface of the image carrier for a specified amount to thereby scrap off toner from the surface;

a vibratable member to which the blade member is fixed;

and

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a vibrating unit that vibrates the vibratable member in

such a manner that toner that is not in contact with the end of the blade member is vibrated.

62. An image forming apparatus, in which a latent image is formed  
5 on an image carrier, the latent image is developed with a toner having sphericity of 0.96 to 1.00 based on a flow type particle image analyzer (FPIA), the toner image is transferred onto a recording medium, the image forming apparatus comprising:

a blade member having an end, wherein the end touches a  
10 surface of the image carrier;  
a vibratable member to which the blade member is fixed; and  
a vibrating unit that, after the toner image is transferred onto the recording medium, vibrates the vibratable member so that the end of the blade member vibrates to thereby clean toner remaining on the  
15 image carrier.

63. The image forming apparatus according to claim 62, wherein the toner is produced by a polymerization method.

20 64. The image forming apparatus according to claim 62, wherein the end of the blade member is formed with a material having less affinity for the toner than other portion of the blade member.



65. The image forming apparatus according to claim 62, wherein an external additive is added to the toner, and the first end of the blade member is formed with a material having less affinity for the external additive than other portion of the blade member.

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66. The image forming apparatus according to claim 62, wherein amplitude of vibrations of the end of the blade member is smaller than an average particle size of the toner.

10 67. The image forming apparatus according to claim 62, wherein amplitude of vibrations of the end of the blade member can be set as desired.

15 68. The image forming apparatus according to claim 67, further comprising an amplitude controlling unit that electrically controls the amplitude of vibrations of the end of the blade member.

69. The image forming apparatus according to claim 62, wherein the vibrating unit is a piezoelectric element.

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70. The image forming apparatus according to claim 69, further comprising a voltage applying unit that applies an alternating voltage to the piezoelectric element.

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71. The image forming apparatus according to claim 62, further comprising an amplitude controlling unit that changes amplitude of vibrations of the end of the blade member when the toner image is being formed and when toner image is not being formed.

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72. The image forming apparatus according to claim 62, further comprising an amplitude controlling unit that changes amplitude of vibrations of the end of the blade member based on at least one of an amount of toner deposited on the image carrier, number of images  
10 formed, environmental conditions, and an amount of toner replenished.

73. A cleaning device comprising:

a blade member having an end, wherein the end touches a surface of a image carrier that carries a toner image made of toner  
15 having sphericity of 0.96 to 1.00 based on a flow type particle image analyzer;

a vibratable member to which the blade member is fixed; and

a vibrating unit that vibrates the vibratable member so that the end of the blade member vibrates to thereby clean the toner on the

20 image carrier.

74. The cleaning device according to claim 73, wherein the toner is produced by a polymerization method.

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75. The cleaning device according to claim 73, wherein the end of the blade member is formed with a material having less affinity for the toner than other portion of the blade member.
- 5 76. The cleaning device according to claim 73, wherein an external additive is added to the toner, and the end of the blade member is formed with a material having less affinity for the external additive than other portion of the blade member.
- 10 77. The cleaning device according to claim 73, wherein amplitude of vibrations of the end of the blade member is smaller than an average particle size of the toner.
78. The cleaning device according to claim 74, wherein amplitude of  
15 vibrations of the end of the blade member can be set as desired.
79. The cleaning device according to claim 75, wherein amplitude of vibrations of the end of the blade member can be set as desired.
80. The cleaning device according to claim 76, wherein amplitude of  
20 vibrations of the end of the blade member can be set as desired.
81. The cleaning device according to claim 77, wherein amplitude of vibrations of the end of the blade member can be set as desired.

82. The cleaning device according to claim 78, further comprising an amplitude controlling unit that electrically controls the amplitude of vibrations of the end of the blade member.

5 83. The cleaning device according to claim 79, further comprising an amplitude controlling unit that electrically controls the amplitude of vibrations of the end of the blade member.

84. The cleaning device according to claim 80, further comprising an  
10 amplitude controlling unit that electrically controls the amplitude of vibrations of the end of the blade member.

85. The cleaning device according to claim 81, further comprising an  
15 amplitude controlling unit that electrically controls the amplitude of vibrations of the end of the blade member.

86. The cleaning device according to claim 73, wherein the vibrating unit is a piezoelectric element.

20 87. The cleaning device according to claim 86, further comprising a voltage applying unit that applies an alternating voltage to the piezoelectric element.

88. A process cartridge comprising:

an image carrier that carries a toner image made of toner;

and

a cleaning unit having

5 a blade member having an end, wherein the end touches  
a surface of a image carrier that carries a toner image made of toner  
having sphericity of 0.96 to 1.00 based on a flow type particle image  
analyzer;

a vibratable member to which the blade member is fixed;

10 and

a vibrating unit that vibrates the vibratable member so  
that the end of the blade member vibrates to thereby clean the toner on  
the image carrier.

15 89. An image forming apparatus comprising a plurality of process  
cartridges, each process cartridge including

an image carrier that carries a toner image made of toner;

a charging unit that electrically charges the image carrier;

a developing unit that develops the toner images on the image

20 carrier;

a transfer unit that transfers the developed toner image onto a  
recording medium; and

a cleaning unit having

a blade member having an end, wherein the end touches  
25 a surface of a image carrier that carries a toner image made of toner

having sphericity of 0.96 to 1.00 based on a flow type particle image analyzer;

a vibratable member to which the blade member is fixed;

and

5 a vibrating unit that vibrates the vibratable member so that the end of the blade member vibrates to thereby clean the toner on the image carrier.

90. An image forming apparatus, in which a toner image is formed  
10 on an image carrier with a toner having sphericity of 0.96 to 1.00 based on a flow type particle image analyzer (FPIA), the image forming apparatus comprising:

a cleaning unit that includes

a blade member having an end, wherein the end touches

15 a surface of the image carrier;

a vibratable member to which the blade member is fixed;

and

a vibrating unit that vibrates the vibratable member so  
that the end of the blade member vibrates to thereby clean toner  
20 remaining on the image carrier,

wherein friction between the image carrier and the blade member is less when the vibrating unit vibrates the vibratable member than when the vibrating unit does not vibrate the vibratable member.

91. The image forming apparatus according to claim 90, further comprising a friction detection unit that detects the friction between the image carrier and the blade member.

5 92. The image forming apparatus according to claim 91, further comprising a friction detection unit that detects the friction based on detection of a rotational torque of the image carrier.

93. The image forming apparatus according to claim 91, further  
10 comprising a friction detection unit that detects the friction based on detection of a drive current of a motor that drives the image carrier.

94. The image forming apparatus according to claim 91, further  
15 comprising a friction control unit that controls the friction by controlling the friction.

95. The image forming apparatus according to claim 92, further comprising a friction control unit that controls the friction by controlling the rotational torque.

20 96. The image forming apparatus according to claim 93, further comprising a friction control unit that controls the friction by controlling the drive current.

97. The image forming apparatus according to claim 94, wherein the  
25 friction control unit electrically controls the friction.

98. The image forming apparatus according to claim 95, wherein the friction control unit electrically controls the rotational torque.

99. The image forming apparatus according to claim 96, wherein the  
5 friction control unit electrically controls the drive current.

100. The image forming apparatus according to claim 90, wherein the vibrating unit is a piezoelectric element.

101. The image forming apparatus according to claim 90, wherein the  
10 vibrating unit vibrates the vibratable member in accordance to area of the toner image.

102. A cleaning device comprising:

15 a blade member having a first end and a second end, wherein the first end touches a surface of an image carrier that carries a toner image made of toner;

a vibratable member to which to the second end of the blade member is fixed; and

20 a vibrating unit that vibrates the vibratable member so that the first end of the blade member vibrates to thereby clean the toner from the surface of the image carrier,

wherein friction between the image carrier and the blade member is less when the vibrating unit vibrates the vibratable member  
25 than when the vibrating unit does not vibrate the vibratable member.



103. The cleaning device according to claim 102, wherein the vibrating unit vibrates the vibratable member in accordance with the frictional.
- 5 104. The cleaning device according to claim 102, wherein the vibrating unit vibrates the vibratable member in accordance with any one of a rotational torque of the image carrier and a drive current of the motor that rotates the image carrier.
- 10 105. The cleaning device according to claim 102, wherein the vibrating unit is a piezoelectric element.
106. The cleaning device according to claim 102, wherein the vibrating unit vibrates the vibratable member in accordance with area of  
15 the toner image.
107. A process cartridge comprising:  
an image carrier that carries a toner image made of toner;  
and  
20 a cleaning unit having  
a blade member having a first end and a second end,  
wherein the first end touches a surface of an image carrier that carries a toner image made of toner;  
a vibratable member to which to the second end of the  
25 blade member is fixed; and

a vibrating unit that vibrates the vibratable member so that the first end of the blade member vibrates to thereby clean the toner from the surface of the image carrier,

wherein friction between the image carrier and the blade member is less when the vibrating unit vibrates the vibratable member than when the vibrating unit does not vibrate the vibratable member.

108. An image forming apparatus comprising a plurality of process cartridges, each process cartridge including

10 an image carrier that carries a toner image made of toner;  
a charging unit that electrically charges the image carrier;  
a developing unit that develops the toner images on the image carrier;

a transfer unit that transfers the developed toner image onto a recording medium; and

a cleaning unit having  
a blade member having a first end and a second end,  
wherein the first end touches a surface of an image carrier that carries a toner image made of toner;

20 a vibratable member to which to the second end of the blade member is fixed; and

a vibrating unit that vibrates the vibratable member so that the first end of the blade member vibrates to thereby clean the toner from the surface of the image carrier,

25 wherein friction between the image carrier and the blade

member is less when the vibrating unit vibrates the vibratable member than when the vibrating unit does not vibrate the vibratable member.

109. A method of cleaning toner remaining on an image carrier,  
5 wherein the toner having sphericity of 0.96 to 1.00 based on a flow type particle image analyzer, comprising:

fixing a blade member, having an end, to a vibratable member such that the end of the blade member touches the image carrier; and  
vibrating the vibratable member so that the end of the blade  
10 member vibrates to thereby clean the toner on the image carrier.

110. The method according to claim 109, wherein the toner is produced by a polymerization method.

15 111. The method according to claim 109, wherein the first end of the blade member is formed with a material having less affinity for the toner than other portion of the blade member.

112. The method according to claim 109, wherein the vibrating unit is  
20 a piezoelectric element.

113. The method according to claim 112, further comprising applying an alternating voltage to the piezoelectric element.

114. The method according to claim 109, further comprising:  
changing amplitude of vibrations of the end of the blade member  
when the toner image is being formed and when toner image is not  
being formed.

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115. The method according to claim 109, further comprising:  
changing amplitude of vibrations of the end of the blade member  
based on at least one of an amount of toner deposited on the image  
carrier, number of images formed, environmental conditions, and an  
10 amount of toner replenished.